DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange, among interested persons, of information concerning recent developments in various digital computer projects

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

Vol. 3, No. 3 July 1951

TABLE OF CONTENTS

Approved by
The Under Secretary of The Navy
27 August 1951

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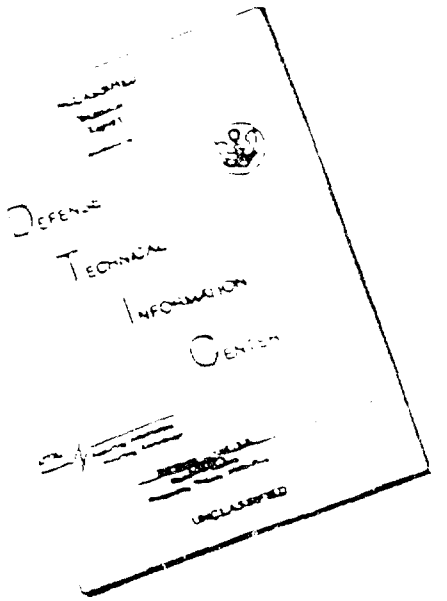

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UNIVAC

Five complete UNIVAC SYSTEMS have been delivered and are now in regular operation. The most recent delivery was to the Atomic Energy Commission at New York University, New York.

UNIVAC SYSTEM VI has been purchased by the Bureau of Ships, U. S. Navy, and has passed its acceptance tests, in Philadelphia. It was shipped to the David Taylor Model Basin and is now being installed there. UNIVAC SYSTEM VII is substantially through final testing, in Philadelphia, while UNIVAC SYSTEM VIII is in its final test stages.

Earlier this year, the Census Bureau computer, UNIVAC SYSTEM I was shipped to Washington, D. C. after being operated in Philadelphia by the Census Bureau slightly under two years.

The performance figures over the past three years indicate the average usability of approximately 80% of a 168-hour week, with 10% regular scheduled maintenance time, and a reliable maximum of 10% non-scheduled maintenance time. This figure was achieved principally in the Philadelphia plant, and some slight decrease in total usability may occur in the field. The figure, however, should never fall below 70% of a 168-hour week, and, with excellent maintenance, can approach 90%.

Considerable research is being focused on further improvement in input-output control equipment and in the development of additional auxiliary equipment.

MOORE SCHOOL AUTOMATIC COMPUTER (MSAC)

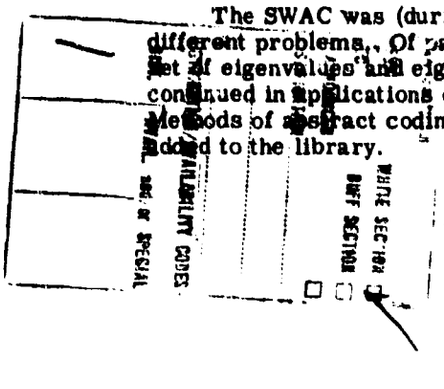
During the past quarter, considerable effort has been directed toward engineering the physical details of the MSAC, including the power-distribution system, the cable interconnections, and the grounding system. A detailed set of notes describing the logic of the machine has been set up. All pulse transformers, except those for the memory units, were completed. The assembly and measurement of the plug-in electrical delay line units was begun. Chassis production for the main body of the MSAC continues with 72 chassis out of the required 159 completed.

THE SWAC

During the past quarter, a magnetic drum memory of 4096 words was put into operation as an integral part of the SWAC. Information is stored serially on the drum on 128 distinct channels with 32 words per channel.

Transfers to and from the drum are most efficiently handled in blocks of 32 words, which is just the number of words on any one track. A word in position P on track T on the drum is transferred into address A + P in the high-speed electrostatic storage tube memory, where A and T are specified in the transfer command. This makes it possible to begin the transfer with the first number that becomes available, and to know that the transfer persists for precisely one revolution time of the drum. The drum rotates at 3600 rpm; so 32 words are transferred in approximately 17,000 microseconds. Since there is no wait-time, the access time per word on the drum (when handled in blocks of 32 words) is about five hundred microseconds.

The SWAC was (during the past quarter) in operation for 875.4 hours, working on thirty different problems. Of particular numerical interest has been the determination of the full set of eigenvalues and eigenvectors of a 45th-order symmetric matrix. Experiments have continued in applications of the conjugate gradient method to systems of linear equations. Methods of abstract coding were developed, and special multi-precision subroutines have been added to the library.



BURROUGHS LABORATORY COMPUTER

A computer essentially similar to the Burroughs Laboratory Computer is under construction for Wayne University. During the construction period, the staff of the Wayne University Computation Laboratory is using the computer in the Burroughs Laboratory on a 20-hour-per-week schedule on their computation problems.

In addition to the Wayne University work, the computer is being used about 25 hours per week on problems for outside customers and 15 hours per week on Burroughs computation problems, maintenance, and engineering improvements. Recent computations include turbo-engine design and performance, stresses in pipes, data reduction, antenna calculations, and cam design.

CONSOLIDATED ELECTRONIC DIGITAL COMPUTER, MODEL 30-201

The breadboards of the control, the arithmetic, and the memory circuits have now been coupled, and the integrated computer is under test. Work is proceeding on developing and running test routines, checking subroutines, and solving problems including generation of prime numbers, mass-spectrometer analysis, partial differential equations, etc.

The prototype packaged computer is still under construction and current estimates indicate completion in late summer. In the meantime, the breadboard system is being used for various application problems. The remote-control console, incorporating the photo-electric reader, output punch, and format control which will form part of the prototype, is being used with the breadboard.

Development is proceeding on IBM punched-card input-output.

MONROBOT ELECTRONIC CALCULATOR

The MONROBOT, built by the MONROBOT Corporation, Morris Plains, New Jersey, a subsidiary of the Monroe Calculating Machine Company, is a compact, ruggedized, general-purpose decimal computer of moderate price. The number length of twenty decimal digits, with centrally located decimal point, largely eliminates the need for scaling or setting of decimal point. Neither overflow nor translation techniques are considered necessary. Average office personnel are said to become familiar with MONROBOT operation the first day. It prints out results on 8-1/2-inch wide paper roll or perforates a paper tape, as desired.

MONROBOT V is complete in one desk-size unit, ready to plug in and perform. MONROBOTs can be supplied with storage capacities to suit special requirements.

THE OAK RIDGE AUTOMATIC COMPUTER (ORACLE)

The ORACLE (Oak Ridge Automatic Computer, Logical Engine) is a general purpose digital computer, jointly designed and constructed by the staffs of Argonne National Laboratory, Lemont, Ill., and Oak Ridge National Laboratory, Oak Ridge, Tennessee at ANL for use at ORNL. Construction is under the supervision of J. C. Chu and was begun in November 1951. The ORACLE is a parallel, asynchronous machine operating in the binary number system utilizing a fixed binary point. The principle engineering characteristics of the machine are as follows:

Register Capacity	40 bits
Allowed Adder Carry Time	5 microseconds
Allowed Time Per Shift	6 microseconds
Multiplication Time	240-440 microseconds

(Depending upon number of 1's in the multiplier)

Division time	440 microseconds
(9 bit command code, 11 bit address)	
Number Word Size	40 bits
Other Word Size	20 bits
Memory Type	Williams
Maximum Memory Capacity	2048 words
Memory Minor Cycle (Maximum Access Time)	20 microseconds
Major Memory Cycle (Mode 1024)	20.48 milliseconds
(Mode 2048)	40.96 seconds
Number of Vacuum Tubes	3500

There are two operating modes available in the ORACLE memory system. In either case, dot-dash display is used. The dot is used to regenerate a zero, and dot-dash is used to regenerate a one. Mode 1 is the 1024-word mode, in which time multiplex is used between a pair of Williams tubes to determine the stored information for each bit. In this arrangement, when either tube reads a "1" signal, a "1" is replenished to both. This method overcomes the most common type of screen blemish which would prevent storage of a "1" (dot-dash). Mode 2 is the 2048-word mode, in which each tube stores 1024 words. The first tube is regenerated in the first half of a major cycle and the second tube in the second half of the major cycle.

Teletype equipment is used for the input-output media. The general code and logical structure are similar to that of the Institute for Advanced Study computer.

At present the ORACLE is undergoing the final engineering test at Argonne. The maximum repeated consulting number of the memory (commonly called "read-around") is about 200. The ORACLE will be installed at Oak Ridge early this fall to be used by the ORNL mathematical panel under the direction of A. S. Householder.

Four magnetic tape auxiliary memory units are under design and construction at Argonne. The two inch wide tape contains 42 parallel channels of which two are used for control purposes. A 42 channel recording head 2 inches wide is used. The packing density is 100 bits per inch per channel. The start/stop time is about 1.5 milliseconds. This auxiliary memory unit, however, will not be installed with the ORACLE until late fall of 1953.

THE NAREC

The Naval Research Laboratory's high-speed, electronic, digital computer (NAREC) has recently been placed on a daily operation schedule of eight hours useful computation plus four hours for engineering checks and maintenance. At present, the computer is operating with a magnetic-drum memory and with Flexowriters being used for both input and output. Electrostatic memory units for 1024 words are being checked separately prior to being added to the computer system. Magnetic-tape input and output equipment is also under external test. It is planned that the complete system with electrostatic memory and magnetic tape input-output should be in operation later this year.

THE ELECOM COMPUTERS

The Electronic Computer Division, Underwood Corporation moved on 28 May 1953 to new and larger quarters at 35-10 36th Avenue, Long Island City 6, New York, New York.

ELECOM 100

The second Elecom 100 was delivered to Reeves Instrument Corporation at the end of March, 1953 for the use of the Navy's Project Cyclone. It was recently used in the solution of a problem involving a system of 14 linear differential equations. The time required was over 60 hours, during which no computer errors occurred; this included error-free operation

of the magnetic tape for considerably more than 20,000 blocks. Additional Elecom 100 computers are now in process of manufacture.

ELECOM 120

Engineering design of the Elecom 120, which is a moderately priced decimal computer with a 1000 word magnetic drum memory, was completed and the first 5 machines are now in production.

ELECOM 200

The Elecom 200, a large-scale decimal computer, having a magnetic drum memory of 10,000 word capacity, is to be used at the Pentagon by the Office of the Chief of Ordnance for logistics problems. It has been undergoing engineering test, and the majority of the internal operations, including addition, subtraction, multiplication, square rooting, and conditional transfer have been completely checked out.

The company now has a staff of mathematicians and programmers and will soon be prepared to provide computing and programming services. An Elecom 100 will be available initially for this service, and will be supplemented later by an Elecom 120. Training of both programmers and maintenance personnel can also be provided.

UNIVERSITY OF ILLINOIS COMPUTER (ILLIAC)

The University of Illinois Digital Computer (ILLIAC) is regularly used for problems arising in university research. The machine is scheduled for engineering and maintenance (including improvements) for 4-1/2 hours per day and for problem solving 11-1/2 hours per day. Out of the 11-1/2 hour period, the machine requires attention about 1-1/2 hours, thereby providing about 10 computing hours per day.

A recent improvement in the Williams memory makes it possible to guarantee a read-around ratio of 80.

AIR FORCE MISSILE TEST CENTER COMPUTER (FLAC)

System testing of the FLAC (see the Digital Computer Newsletter for April 1953) began in late January 1953. The computer proper is now operational with the internal memory and either punched paper tape or magnetic wire input-output equipment. The magnetic tapes and their circuitry in addition to the perforated-tape-to-magnetic-tape and magnetic-tape-to-perforated-tape conversion units remain to be tested.

NAVAL PROVING GROUND CALCULATORS

During the past three months the Aiken Relay Calculator (Mark II) has continued to operate on a 24-hour per day schedule. The Mark III Calculator has operated on the same schedule; however, the entire month of March was spent in installing improvements to the Calculator.

The operating efficiency of the Mark II continues above 85 percent; for the month of May the Mark II had an efficiency of 90 percent which is the most successful record for any similar period. The Mark III efficiency for the past three months of productive operation averaged 62 percent.

The Computer Research and Development Group installed a new checked-sequencing system in the Mark III Calculator which permits more rapid changing of problems. The new system not only loads the program storage drum five times faster than was possible under the

old system, but also includes complete checking of the program storing process and a "modulo 2 bit-count check" on every program word used during computation. Furthermore, in order to detect wrong program transfers during computation, a circuit is provided which makes a "modulo 2 bit-count check" on that part of the transfer code which represents the address of the program word to which the transfer is to be made. The address of the word actually obtained also undergoes such a bit-count, and if the two bit-counts do not agree the machine stops with the "wrong call" alarm light on.

In addition to the heavy program of urgent ballistic computation performed on both Calculators during the past quarter, a research problem involving computations, by the method of characteristics, of supersonic flow past ogival missiles is now being solved on the Mark III Calculator.

THE INSTITUTE FOR ADVANCED STUDY COMPUTER

For the period March 1953 to May 1953 the IAS machine has been in operation a total of 1360 hours. Of this time 1122 hours were available for computation and the machine, in fact, operated 918 of these hours. Thus, it was in operation approximately 82% of the available time. During this period a large variety of problems were solved including a number of meteorological forecasts, a variety of hydro-dynamical calculations, a mathematical approach to biology, some problems in physical chemistry, and a variety of other calculations.

A magnetic drum of 2000-word capacity has been completed and attached to the machine. This drum is an 80-channel unit, the first half of which has been placed in operation.

THE LOGISTICS COMPUTER

Construction of the ONR Logistics Computer, described in the July 1952 issue of the Digital Computer Newsletter, has been completed. This special purpose computer was installed at George Washington University in February 1953 by Engineering Research Associates, Inc., of St. Paul, Minnesota. It is currently being operated as a research instrument by the George Washington University Logistics Research Project for the Office of Naval Research.

In addition to the computer, magnetic tape input and output equipment was delivered in May 1953. The magnetic input is capable of handling 300 characters per second on high speed and 150 characters per second on low speed, while the magnetic output operates up to 600 characters per second. In connection with the magnetic input-output equipment, a unit was received which is capable of converting magnetic tape information to paper tape information or to electric typewriter printout. Equipment is also available for conversion of IBM cards to paper tape.

ABERDEEN PROVING GROUND COMPUTERS

THE ORDVAC

Recent efforts to improve the effective read around ratio of the ORDVAC's electrostatic memory are expected to lead to a ratio beyond 100. These efforts include procurement of a full complement of RCA cathode ray memory tubes of a new design and incorporation of a new memory pulsing system developed by the University of Illinois for use on the ILLIAC. Machine availability since 1 January 1953 has averaged 123 hours per week.

THE EDVAC

Many circuit changes have recently been completed to improve machine reliability and a teletype page printer has been added to the machine output. Excluding a 6-week period in which the machine was shut down to incorporate modifications to permit later use of a magnetic-drum

memory and additional input-output equipment, the EDVAC has been available for productive operation for an average of 78 hours per week, since 1 January 1953.

THE ENIAC

A new word shifting device was designed, constructed, and recently placed in service. This unit reduces the time required for a shift order (multiplication by a positive or negative power of 10) to less than one third of the time previously taken. The ENIAC has shown an average available machine time since 1 January 1953 of 114 hours per week.

WHIRLWIND I

The Whirlwind I computer continues to be used for scientific and engineering problems for about 30 hours per week. A total of 115 such programs were run during the period March 1 June 1, 1953. Most of these were parts of long-range problems introduced during the previous quarter.

Testing of the auxiliary-magnetic-drum (discussed in previous issues of the Newsletter) is complete and the unit is available for use by the programmers. The read-in program is now stored on the magnetic drum and is read into electrostatic storage when read-in is requested. Reliability studies of the drum system will continue during the summer.

The Scientific and Engineering Computation Group are determining suitable means of incorporating the magnetic drum into a conversion scheme, designed to eliminate, to a large extent, the logical distinction between storage on the drum and storage in the computer's electrostatic storage system. Suitable post-mortem and mistake-diagnosis programs will be considered an integral part of this system.

Installation of the second bank of tubes in electrostatic storage has been completed and the system is operating reliably.

Extensive use has been made of delayed printing using magnetic tape. Data from the computer is stored rapidly on the tape and, at a convenient time later, is printed at a slower speed without interfering with computer operation.

Photographs are being taken of scope displays so that larger amounts of data can be read out and analyzed. Operation of the camera is controlled by the computer program.

ERA 1103

The ERA 1103 is a general-purpose digital computer for applications requiring large storage capacity and programming versatility. All internal operations are in the binary system, the basic word size being 36 bits. The instruction code is a two-address system utilizing a 6-bit command and two 15-bit addresses to make up a single order word. The four classes of storage which are individually addressed include 16,384 words of magnetic drum storage, 1024 words of electrostatic storage and the Quotient-Multiplier Register and Accumulator. The accumulator is double length for formation of products. Four magnetic tape units are provided for supplementary storage. Information is transferred to and from these tapes in blocks. Negative numbers are denoted in the One's Complement system and the radix point is considered fixed at the low order end of the word. A wide option of terminal equipment may be obtained including basically a photoelectric tape reader, a directly connected typewriter, and a high-speed tape punch. Optional equipment may include punched card equipment, on line teletype communication circuits and a variety of analogue equipment.

HUGHES AIRBORNE CONTROL COMPUTER

This computer is a very compact digital computer developed for use in an airborne control system. The computer operates on 17-bit words (sign bit plus 16-bit number). The order

code includes all arithmetic operations plus transfer operations and some logical operations. The memory contains 2500 words on a magnetic drum. All operations within the computer take place in the serial mode. Static circuitry of the flip-flop type is used and the circuits are placed on plug-in packages. Extensive use has been made of sub-miniature tubes, printed circuits and other miniaturization techniques. An analogue-to-digital converter provides the inputs required for the machine. In a similar manner the output of the computer is converted to analogue quantities for use in control.

ELLIOTT-N.R.D.C. COMPUTER 401 Mk 1

The Elliott-N.R.D.C. Computer 401 Mk 1 was constructed by Elliott Brothers Ltd. in their Research Laboratories at Boreham Wood, England, for the National Development Research Corporation, London, England. The 401 Mk 1 was demonstrated at the Physical Society Exhibition in London in April 1953. Less than one year was required to develop and complete this computer which was planned as a complete small size machine which would be useful in its own right while providing an opportunity to test the design and packaging techniques.

The 401 Mk 1 operates in the serial mode upon 32 digit binary numbers at a basic bit handling rate of 333 kc/s. The arithmetic unit contains information in single word length magnetostrictive delay lines. Two such registers compromise the accumulator; four more are used as multiplier, multiplicand, instruction, and general-purpose registers. The numbers handled by the machine range from $1-2^{-31}$ to $2^{-31}-1$ with a fixed binary point. The thirty-second bit of each number is a sign bit. An order word contains a ten-bit address for the operand of the order, four three-bit order digit groups, and a ten-bit address of the next order. These order digit groups act as partial command codes and the sequence of all four make up the complete command. In a sense this shifts some of the sub-command complexity from the control unit of the machine to the programmer.

The internal memory is a magnetic disc 9 inches in diameter containing 8 tracks on the lateral surface; each track contains 128 32-bit words. The disc rotates at 4600 rpm, with a rotation period of 13.1 milliseconds and a bit-rate of 333 kc/s. Electronic switching is used for track selection. Fifteen more tracks may be utilized if desired, a relay switching operation being utilized to select which one of 16 tracks is used as the eighth of the electronically selected tracks.

Input is provided by a photo-electrically sensed 5-level paper tape reader operating at 40 frames per second. The output is an electric typewriter operating at 10 characters per second.

Addition and subtraction may be performed in 200 microseconds, exclusive of access. Multiplication requires from 7 to 10 milliseconds, depending upon sign. Average access time is 6-1/2 milliseconds. The two-address system is, however, conveniently suited to optimum or minimum access programming and some time can be saved through the exercise of care on the part of the programmer.

Packaged plug-in units (see Fig. 2) and miniature tubes have been used in the 401 Mk 1 and reliability and ease of maintenance were prime considerations in the construction. One section of the cabinet contains a cooling fan for air circulation throughout the machine. The main cabinet is 13′ long by 2′ deep and 7-1/2′ high. A mobile maintenance cart and a cart containing the input-output equipment are each about 2-1/2′ by 3′ by 4′ (see Fig. 1). The main cabinet weighs 2200 lbs. The 401 Mk 1 contains about 500 tubes and requires 5 kva of power.

NICHOLAS

In addition to the ELLIOTT-N.R.D.C. Computer 401 Mk 1, Elliott Brothers Ltd. have completed Nicholas, a Nickel-Delay-Line-Storage computer. The internal memory of the machine consists of 64 nickel magnetostriction delay lines, each containing sixteen 32-bit words. Bit circulation occurs at approximately a 50 kc rate. In addition, five word-length lines are used for the arithmetic and control registers. The average access time to the

ELLIOTT - N.R.D.C. COMPUTER 401 MK 1

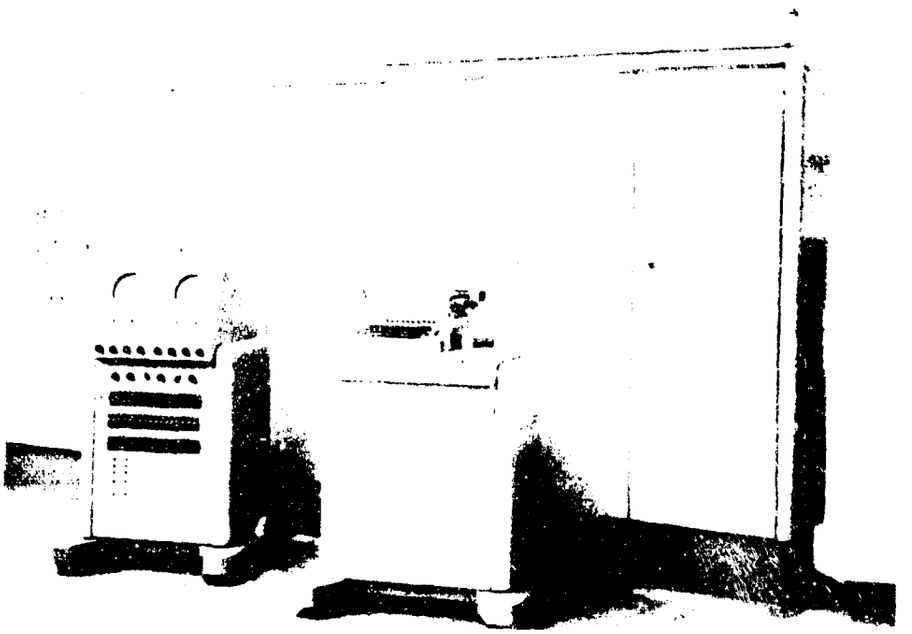


Figure 1 - View of complete machine with maintenance and input-output equipment carts

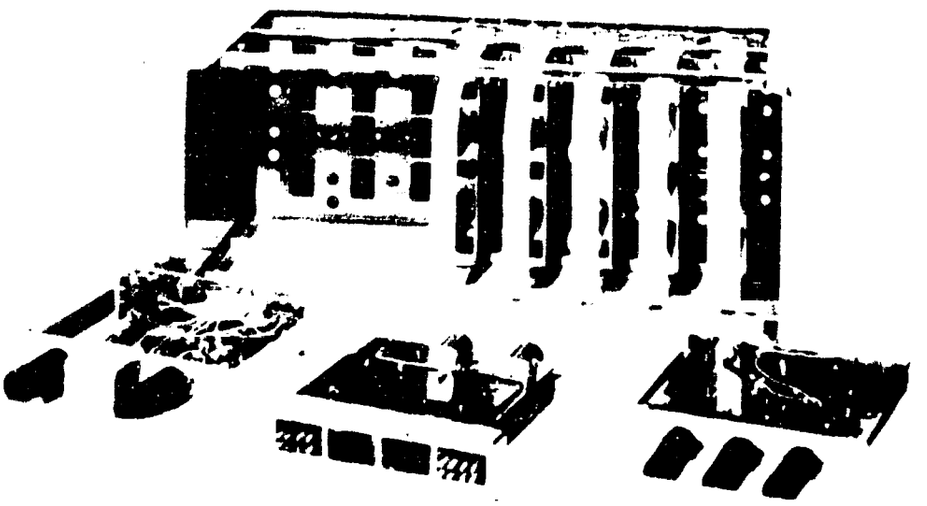


Figure 2 - View of plug-in packages
(Package holder is normally permanently mounted)

storage is 6-1/4 milliseconds and the average computing speed is said to be approximately 100 operations per second. The 32-bit words may either be a number or contain two 16-bit orders. Each order has a 6-bit command code and a 10-bit address. Input is 5-level punched paper tape and output is either 5-level punched tape or typewritten page copy. This machine has been operating since January 1953. A computing and programming (if desired) service is currently available.

DATA PROCESSING AND CONVERSION EQUIPMENT

Solid Acoustic Delay Line Memory Unit

The Computer Control Corporation, 106 Concord Avenue, Belmont 78, Massachusetts has announced a Solid Acoustic Delay Line Memory Unit - Model 3C1-384. This 5 tube unit contains a solid quartz delay line manufactured by R. D. Brew and Company of Belmont, Massachusetts, and is a complete unit for the recirculation of 384 pulses at a 1 megacycle pulse repetition rate. The carrier frequency used is 20 megacycles. The Computer Control Corporation is also prepared to undertake other applications of solid acoustic delay lines.

Contact Telereader

Telecomputing Corporation, 133 East Santa Anita Avenue, Burbank, California has announced the Contact Telereader, a device for recording digital information from graphical records. This device tracks a curve under manual control and information may be recorded from calibrated indicators and recorded manually or may be read out electronically into a Teleducer (See DCN for April 1953) and converted to digital information electrically. A series of Program Units are available for recording the Teleducer outputs in a flexible manner in page copy, perforated-tape or punched cards.

Character Display Signal Generator

Wang Laboratories, 296 Columbus Avenue, Boston 16, Massachusetts have announced the Model DS-157 Character Display Signal Generator. This generator supplies the necessary signals for successively intensifying the dots in a 5 by 7 array to produce a character formed of the appropriate dots. A matrix of 35 magnetic cores is used with a single turn sensing winding threaded through the appropriate cores for each character. As the successive positions in the core matrix are scanned, the appropriate dots on the cathode ray screen are intensified where the desired sensing winding is activated. A display speed of 10,000 characters per second is possible. With this device any desired configuration in a 5 by 7 matrix may be obtained.

COMPUTER COURSES

REMINGTON RAND INC. (UNIVAC TRAINING COURSES)

Remington Rand is now offering a Training Program in Electronic Computing Systems. The following courses are held at 315 Fourth Avenue, New York 10, New York:

Orientation for Executives	4 days	Sept. 28, 1953
Introductory Course in Computers	2 weeks	Sept. 7, 1953
Elementary Programming	6 weeks	1st Mon. - Even Months
Advanced Programming	6 weeks	3rd Mon. - Odd Months

Sixteen week Technical Engineering Courses for maintenance personnel are offered in Philadelphia, Pennsylvania. Inquiries concerning all courses should be directed to Remington Rand Inc., 1615 L Street, N. W., Washington, D. C.

AVAILABILITY OF DIGITAL COMPUTING SERVICES

Key: (a) Name and Address of Contact
(b) Facilities and their Location
(c) Coding and Mathematical Services
(d) To Whom Available

(1) Engineering Research Associates Division of Remington Rand Inc.

(a) W. Gordon Welchman, Director of Computer Applications, ERA Computation Center, Engineering Research Associates Division of Remington Rand Inc., 555-23rd Street, S., Arlington 2, Virginia.

(b) ERA 1101 Automatic Computer.

(c) Available.

(d) No restriction.

NOTICES

COMPUTER SYMPOSIUM

A Symposium on Digital Computers, Advanced Engineering Techniques, will be held on 3, 4, and 5 August at the Argonne National Laboratory, Lemont, Illinois under the sponsorship of the Physics Division of the Laboratory. The AVIDAC, Argonne's high-speed computer, and the ORACLE, the Oak Ridge high-speed computer, as well as other laboratory equipment will be on display.

JOINT COMPUTER CONFERENCE

The annual joint computer conference, sponsored by the Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Association for Computing Machinery, will be held this year in Washington, D. C., at the Hotel Statler, 16th and K Streets, N. W. on 8, 9, and 10 December 1953.

DCN NEWS ITEM

The Computer Branch of the Office of Naval Research, Washington 25, D. C., solicits news items for inclusion in the Digital Computer Newsletter. Material should be received by 10 March, 10 June, 10 September, or 10 December, for publication in the Newsletter of the following months.